MAN IN THE ARCTIC PROGRAM
Working Paper

Petroleum Tax Policy to Achieve Smooth Economic Growth in Alaska

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THE MAN-IN-THE-ARCTIC PROGRAM

The Man-in-the-Arctic Program, funded by the National Science Foundation, is a long-range research effort intended to develop a basic understanding of the forces of change in Alaska and to apply this understanding in dealing with critical problems of social and economic development. The overall objectives to the program are to:

- Measure and analyze basic changes in the economy, the social conditions, and the population of Alaska.
- Identify significant interactions between outside economic and social forces and Alaska conditions and institutions.
- Analyze specific public problems associated with these interactions and policy alternatives for dealing with them.
- Assist planners and decisionmakers in solving critical problems of concern to both the state and the nation.

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I. INTRODUCTION

Because of a large degree of dependence upon the petroleum industry for tax revenues, the state of Alaska is subject to greater-than-average uncertainty about the level of public services which can be provided to state residents in future years. In addition, the cyclical variability of petroleum revenues, when transmitted through the budgetary process into cyclical expenditure behavior, results in not only a pattern of state expenditures over time which may not be optimal, but also cyclical behavior of the aggregate state economy.

State lawmakers are aware of the problems associated with increasing state spending when revenues temporarily increase and have, in response, created the Alaska Permanent Fund. This fund, in essence, is a permanent savings account for a portion of petroleum royalties and bonus payments, and the revenues placed into it are outside the budgetary process. This reduces the cyclical pattern of petroleum revenues but does not eliminate it. Recent research indicates that an $8 billion general fund surplus could temporarily develop in the mid-1980s, even with the permanent fund channeling revenues away from the general fund.

This paper investigates a method for smoothing out the receipt of petroleum revenues over time through the device of a tax deferral program for the producers of petroleum in the state.[1] Section II discusses the nature of the problem the state faces. Section III describes the basic mechanics of the tax deferral program. Section IV provides a specific example of how the program might be applied to Prudhoe Bay production. Section V analyzes, through use of an econometric model of Alaska, the aggregate and fiscal impacts of the deferred tax program. The final section summarizes the policy implications of the analysis.

II. THE PROBLEM FACING ALASKA

Petroleum revenues will dominate Alaska state government finances for many years to come. In the near term, they will expand rapidly, increasing from their present level of $473 million in 1977 to perhaps $1.75 billion in 1985. Subsequent levels of petroleum revenues are highly dependent upon significant new discoveries on state or private lands. Without such discoveries, revenues will rapidly decline as existing fields, primarily Prudhoe Bay, become depleted. By 1990, revenues may fall

[1]This research was conducted under a grant from the National Science Foundation.

to $.9 billion (Figure 1) and in later years continue to decline.

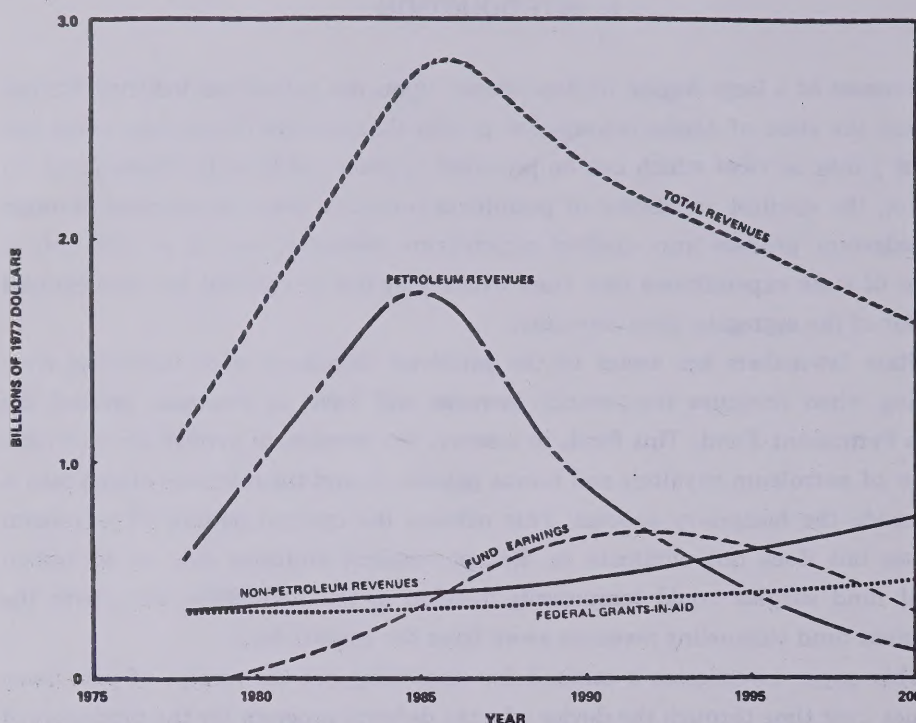

Figure 1. Hypothetical Pattern of Future State Revenues.

Total revenues will follow the general pattern of petroleum revenues. They will increase rapidly in the 1980s, only to peak in the middle of the decade, and decline for many years thereafter.

If the state government were to adopt a budget policy of allowing expenditures to increase at a rate proportional to the increase in state personal income, a situation as depicted in Figure 2 would result. Thirty Percent of state royalty and bonus revenues would be deposited in the permanent fund and insulated from the normal budgetary process. Withdrawals from this fund are prohibited by law, and the principal can be used for profit-making investments but not for financing normal government operations. The permanent fund would rapidly approach $2 billion in value (in 1977 dollars).

In contrast, the state general fund would increase much more rapidly than the permanent fund. Within a 10-year period, it would accumulate nearly $8 billion,

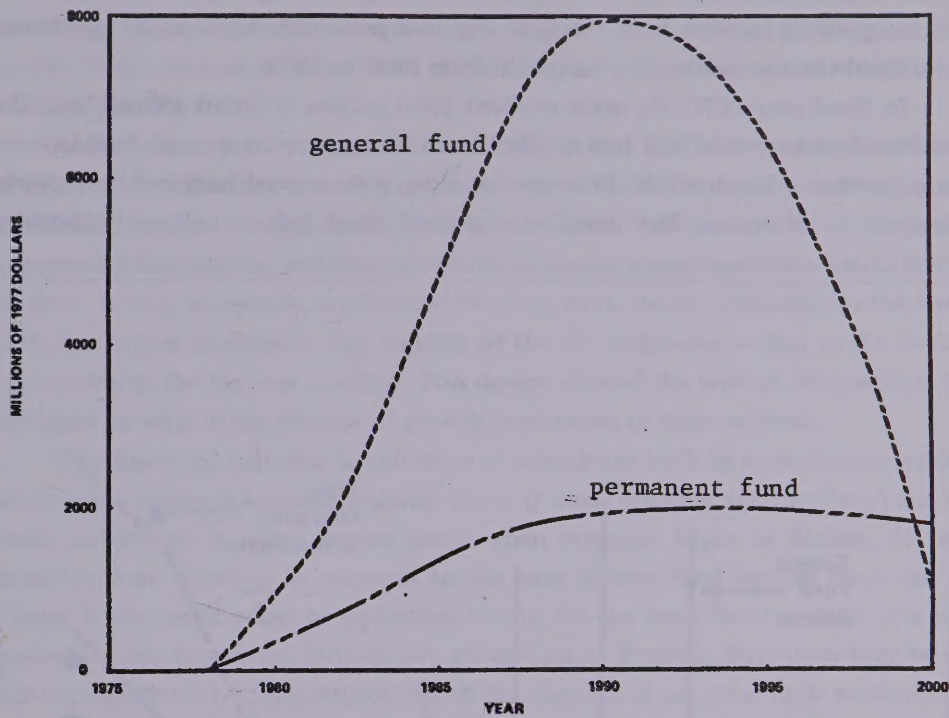

Figure 2. The Projected Pattern of Balance in the Permanent and General Funds (Assuming 30 Percent Contribution Rate to the Permanent Fund)

four times the size of the permanent fund. After 1990, however, the general fund would begin to decline, slowly at first, but then more rapidly, as the accumulated balances are drawn upon to maintain expenditure growth at a constant rate. Over the subsequent 10-year period, the general fund would continue to decline; by 2000, it would be essentially eliminated.

The period of projected rapid growth in the general fund, makes it obvious that this large balance available for increasing the level of state services will present a tremendous temptation. The argument would be that the benefits (to the citizens or the politicians) of an immediate increase in state services outweigh the cost of rapid expansion. The cost, however, would be substantial; when the general fund has been depleted, the level of state government services must be significantly reduced. The rapid drawdown of the general fund would indicate that the state would be "living beyond its means" in the 1990s. since operating expenditures in this case would be much larger than current revenues, and the difference would be made up by reducing the general fund balance.

Examination of the past pattern of state expenditure behavior lends credence to the hypothesis that a significant increase in the general fund balance will result in a corresponding increase in the budget. Figure 3 presents a summary of significant state fiscal events over the 10-year period from 1968 to 1977.

In fiscal year 1970, the state received $900 million in bonus income from the Prudhoe Bay lease sale, and this resulted in an increase in the general fund balance by more than a hundredfold. Prior to that time, state expenditures had been nearly identical to revenues. The new, large general fund balance allowed operating

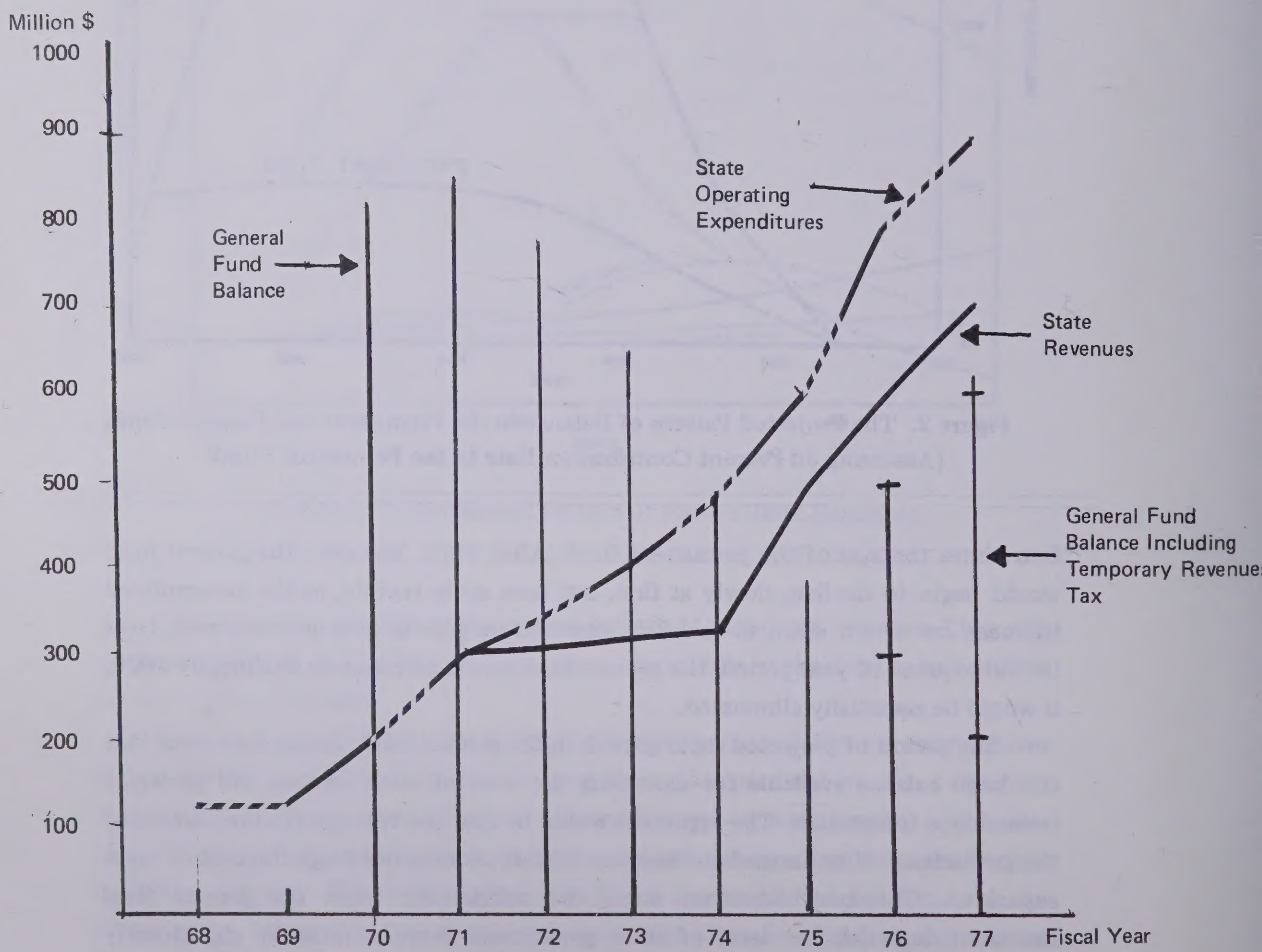

Figure 3. State Budget Growth in Comparison to Revenues and the General Fund

expenditures to grow much more rapidly than revenues in the early 1970s, resulting in a reduction in the general fund balance. By 1975, it was evident that further growth in state expenditures could not long continue without eliminating the general fund, because revenues from oil flowing at Prudhoe Bay would not become available until 1978.

Rather than reduce expenditures in 1976 and 1977, the state adopted a temporary expedient to increase petroleum revenues in the form of a reserves tax on producible reserves in shut-in fields (Prudhoe Bay). This tax existed for 2 years, generated \$494 million, and was refundable to the oil companies when the oil began to flow. It was, in essence, an interest-free loan from the oil companies to the state with the future production tax liability of the oil companies serving as the device against which the tax was credited. This device allowed the level of state services to continue growing in the absence of growth in revenues to finance them.

This historical behavior is indicative of a tendency both to expand state service levels when revenues become available (even if those revenues are transitory) and to resist reductions in state service levels when revenues begin to decline. If this behavior were to occur in response to the large general fund balance projected in Figure 2, the result could be unfortunate both for the state fiscal position and the state economy in general. Beyond the oil and gas at Prudhoe Bay, there may be no further significant resource deposit which the state could tax prior to its production, as was done with the reserves tax. Thus, a rapid depletion of the general fund balance would necessitate a reduction in the level of government services. This would significantly impact the private economy both because of the large size of the government sector and because the decline would come only shortly after a significant "boom" in state government spending.

III. A DEFERRED TAX PROPOSAL

One method of reducing the temptation to spend the general fund balance would be to defer a portion of petroleum tax revenues temporarily and, thus, smooth and lengthen the flow of petroleum revenues to the state. A deferred petroleum tax revenue program could operate essentially as a set of medium-term loans from state government to the oil producers with the loans secured by recoverable oil in the ground which has not yet been produced. (The political connotations of calling the program a loan may not be desirable, although its corporate income tax implications for the oil companies may require it.)

Such a device would have advantages for both the state government and the oil companies. The stream of revenues to the state would be smoothed and lengthened over time, and the funds thus set aside would earn interest and be guaranteed by

oil in the ground. The loans would be used by the oil companies for further exploratory and development activity within the state. The oil companies would have an assured medium-term source of capital. The long-term pattern of loans and repayments would be worked out when the field began producing and would be marginally adjusted annually to take into account changes in the estimated value of reserves in the ground.

The determination of the percentage of tax which should be deferred by the state in any given year is not a trivial problem. It depends upon not only the recoverable reserves, rate of production, and discount rate but also the objective function of state government.

The simplest case seems to be one in which the objective is to maximize the number of years that a constant amount of revenues could be received by the state treasury. The solution would be constrained by the requirement that the value of the recoverable oil still in the ground would be sufficient to provide coverage for the value of the loan outstanding.

The problem can be presented in simplified form algebraically. The present value of total petroleum reservoir production, K, is the price, P, multiplied by the quantity produced, Q, over that portion of the life of the reservoir when the deferral program would operate, T. The price increases over time of the rate, i, while depletion takes place at the rate, p. The discount rate to obtain present value is r.

$$K = \int_0^T Pe^{(i-r)t} \cdot Qe^{(-p)t}\, dt = \int_0^T PQe^{(i-r-p)t}\, dt \qquad 1.$$

The state share of the present value, SH, is a fixed percentage, sh, of the value of output, and this must be recovered from the cash flow over the life of the reservoir.

$$SH = sh \cdot K \qquad 2.$$

For simplicity, in the final year of the program, the share of production which the state receives must be less than or equal to total production in that year.

$$\text{state share of value of production in final year} \leq Pe^{(i)T} \cdot Qe^{(-p)T} \qquad 3.$$

Furthermore, the payment or share which the state receives must follow a specific pattern over time designed to maximize the value to the state of the receipt of petroleum revenues. In the simple case, the present value of the state share

received in each period, AN_t, would be constant.

$$AN_t = \left(\frac{sh \cdot K}{T}\right) e^{rt} \qquad 4.$$

Combining equations yields the following condition for a solution for the maximum number of years, T*, that the state could receive the share, AN_t

$$PQe^{(i-p)T} e^{(-r)T} = \frac{sh}{T} \int_0^T PQe^{(i-r-p)t} dt \qquad 5.$$

or

$$e^{(i-r-p)T} = \frac{sh}{T} \int_0^T e^{(i-r-p)t} dt$$

The annual payment at time t would be

$$AN_t = PQe^{(i-p)T} e^{(-r)(T-t)} \qquad 6.$$

If the annual share payment were constrained to be equal not in present value terms but current value terms, so that the real value of the share declined over time, equation 5 would be changed to read as follows:

$$e^{(i-p)T} = \frac{sh}{T} \int_0^T e^{(i-r-p)T} dt \qquad 7.$$

and the annual payment at time t would be the constant,

$$AN_t = PQe^{(i-p)T} \qquad 8.$$

IV. AN ALASKAN EXAMPLE

A recent estimate of Alaskan state revenues from Prudhoe Bay oil projected that between 1978 and 2000, Alaska will receive \$9.25 billion in royalty income and \$7.77 billion in production tax income. This source of income alone would be sufficient to maintain the budget at its present level for approximately 15 years. The revenue would come rapidly in the early 1980s and then quickly taper off in the 1990s. Table 1 indicates that in the peak year of 1985, combined royalties and taxes would be \$1.478 billion, while by 1990 they would have fallen to \$.731 billion and by 2000, \$.103 billion.

Table 1

Projected Prudhoe Bay Oil Revenues

Year	Production Million Barrels	Wellhead Price $/Barrell	Total Wellhead Value Million $	Royalties Million $	Production Tax Million $	Total Revenues Million $
1980	547.6	8.12	4,446	555	466	1,021
1985	620.6	10.36	6,429	803	675	1,478
1990	240.6	13.23	3,183	397	334	731
1995	71.0	16.87	1,197	149	125	274
2000	21.0	21.49	451	56	47	103
Total 1978-2000				9.250 billion	7.771	17.021

SOURCE: Scott Goldsmith and Lee Huskey, *The Alpetco Petrochemical Proposal: An Economic Impact Analysis,* report for the Alaska State Legislature by the Institute of Social and Economic Research, April 1978.

If a tax deferral program for the production tax on Prudhoe Bay oil were instituted, alternative revenue patterns could be obtained.

Figure 4 compares three different patterns of revenues from Prudhoe Bay production taxes and total petroleum revenues in each case. The two deferred tax cases were determined by trial and error based on the dual constraints that, (1) subject to the pattern of payments chosen, the number of years the program could operate would be maximized and (2) taxes paid in the final year of the program should not exceed the total value of petroleum produced in that year.

The first alternative involves a constant nominal tax payment of $450 million. This would result in tax deferrals between 1980 and 1988 of $1.323 billion, and subsequent repayments to the state of $2.764 billion, including interest on the deferred taxes generated at the rate of 7 percent. This payment schedule would last until 2000, at which time all deferred taxes would have been paid. Total petroleum revenues received would be less for the years before 1988 and greater for the following decade. A maximum deferral of $250 million would occur in 1985, while $368 million would be repaid in 1999, the last full year of the program. This alternative would considerably smooth the revenue stream to the state without restraining to an extreme degree the rapid expansion of revenues in the early years of the program.

The second alternative involves a constant real payment of $250 million in 1979, the initial year of the program. This is based upon an 8 percent rate of discount for future revenues. The payment would balloon to $500 million by 1988

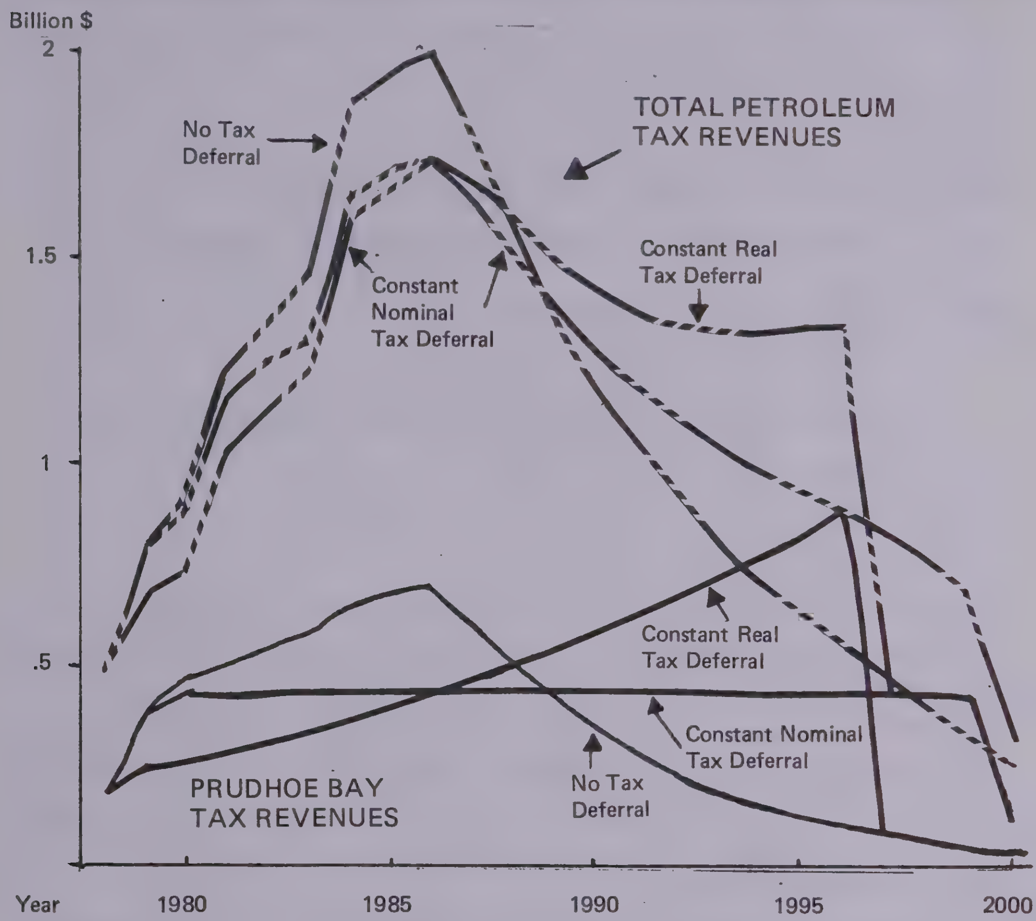

Figure 4. Petroleum Revenues Under Alternative Tax Deferral Programs

and $869 million in 1996, when the program would cease. The pattern of tax payments to the state under this program would begin at a lower level than the alternative of a constant nominal payment. However, by 1986, it would grow beyond the $450 million level and by 1988 would surpass the revenues in the case with no deferred taxes. The program would terminate abruptly with a substantial fall in revenues between 1996 and 1997 of from $1.318 billion to $.462 billion.

V. THE IMPACT OF DEFERRED PETROLEUM PRODUCTION TAXES

The economic impact of the two alternative tax deferral programs developed in

the previous section was assessed using an econometric model of Alaska.[2] The equation which determined the size of the state operating budget was structured in a way to reflect the type of spending behavior observed since the Prudhoe Bay lease sale. That equation was as follows:

$$\begin{aligned} EXOPS = {} & EXOPS(-1) * (POP(-1)/POP(-2) + (RPI(-1)/RPI(-2)) -1) \\ & + G * (GFBAL(-1) - EXGF(-1)) * (GFBAL(-1)/EXGF(-1))) \end{aligned} \tag{9.}$$

where EXOPS = the operating budget
POP = population
RPI = price index
G = a parameter with a value of .01
GFBAL = the general fund balance if the fund is positive, and zero otherwise
EXGF = general fund expenditures

The variables are lagged 1 or 2 years, as noted.

This equation implies that the state operating budget will be sensitive to both the demand for state services through population and the price level, and the supply of available funds in the general fund. The budget will grow proportionately to the growth in population and the price level. In addition, positive levels in the general fund in excess of general fund expenditures will stimulate growth in the budget. Negative levels in the general fund will not lead to downward pressure on the budget because of the "ratchet effect" of government programs. Once an item is in the budget, it is difficult to eliminate it.

When the balance in the general fund is positive and exceeds the level of general fund expenditures, a proportion of the fund is assumed to be used to increase expenditures. This proportion begins at 1 percent and rises as the excess of the general fund balance over general fund expenditures increases. In the year of maximum expenditure, the proportion of the fund consumed is about 3.5 percent.

In a control simulation, no tax deferral program is assumed and revenues from Prudhoe Bay production taxes accrue when liability is incurred. In the other two cases, a portion of revenues is deferred according to the assumptions of the previous section with two immediate effects. First, the general fund balance in early years would be smaller and in later years would be larger than in the control, and this would cause the operating budget to grow less or more rapidly, as the case may be. Second, the deferred tax is assumed to earn a 7-percent return from the oil

[2]See David Kresge and Daniel Seiver, "Planning for a Resource-Rich Region: the Case of Alaska," *American Economic Association Papers and Proceedings*, May 1978.

companies, whereas the overall portfolio of the general fund earns a return of 6 percent.

Table 2 shows the levels of the general fund in the three cases—control, constant nominal payment, constant real payment—as well as the difference of the deferred tax cases from the control case. In the control simulation, the general fund, fueled by petroleum revenues, would rise rapidly through 1989, when it would peak at $9.8 billion, and then fall to a negative value by 1996. This large fund balance would be a stimulus to budget increase.

Table 2

Simulation Results — State General Fund Balance
(million $)

	PNW	PNWCON	PNWCON_ER	PNWINC	PNWINC_ER
1978	745.872	745.872	0.	745.872	0.
1979	1029.84	1029.84	0.	888.84	-141.
1980	1614.22	1573.22	-41.	1268.12	-346.094
1981	2336.59	2228.25	-108.345	1772.99	-563.601
1982	3184.2	2946.99	-237.211	2362.16	-822.044
1983	4091.22	3696.35	-394.87	3011.53	-1079.69
1984	5386.66	4767.48	-619.176	4021.43	-1365.23
1985	6750.6	5884.4	-866.195	5129.59	-1621.01
1986	8049.56	6964.61	-1084.95	6263.4	-1786.16
1987	9036.42	7852.81	-1183.61	7275.07	-1761.35
1988	9625.03	8491.28	-1133.75	8107.02	-1518.01
1989	9788.25	8847.56	-940.695	8727.2	-1061.05
1990	9515.96	8900.	-615.965	9110.22	-405.742
1991	8825.79	8650.45	-175.344	9254.39	428.594
1992	7721.08	8087.43	366.355	9144.81	1423.73
1993	6232.61	7228.22	995.609	8796.63	2564.02
1994	4361.96	6067.92	1705.95	8206.84	3844.88
1995	2100.9	4601.68	2500.78	7380.42	5279.52
1996	-537.598	2834.59	3372.18	6237.75	6775.35
1997	-3570.16	739.027	4309.18	4012.17	7582.32
1998	-6848.91	-1707.98	5140.93	1408.41	8257.32
1999	-10371.6	-4414.23	5957.37	-1594.36	8777.24
2000	-14148.7	-7613.53	6535.17	-4926.8	9221.89

PNW = control simulation
PNWCON = constant nominal tax payment
PNWCON_ER = constant nominal tax payment difference from control
PNWINC = constant real tax payment
PNWINC_ER = constant real tax payment difference from control

In the constant nominal tax payment case, the level of the fund balance would be lower during the years of rapid growth and, subsequently, the decline in later years would be less dramatic. The peak would actually be postponed only one year, but the balance would remain positive for two additional years until 1998. At the termination of the simulation in 2000, the fund balance of —$7.6 billion would be half of the control case of —$14.1 billion.

The case of the constant real tax payment would result in a more substantial divergence of the general fund balance from the control case. The expansion of the general fund would be greatly attenuated in the early 1980s, and the fund itself would not peak until 1991. Its decline would also be more gradual and would not go negative until 1999.

The growth of the operating budget would respond to this difference in the general fund balance very significantly, as indicated in Table 3. In the control case, the budget would increase from $1.1 billion in 1980 to $3.5 billion in 1990 and would double again by 2000 to $7 billion. The small proportion of the balance of the general fund which would augment growth of the budget would result in substantial growth in the long run because of the "ratchet effect" by which the budget grows.

Table 3

Simulation Results — State Operating Budget
(million $)

	PNW	PNWCON	PNWCON_ER	PNWINC	PNWINC_ER
1978	944.	944.	0.	944.	0.
1980	1061.68	1061.68	0.	1060.77	-0.915
1985	1644.57	1589.08	-55.491	1503.14	-141.427
1990	3468.27	3098.1	-370.171	2873.45	-594.822
1995	5300.27	4825.47	-474.797	4753.19	-547.078
2000	7008.63	6405.62	-603.008	6441.87	-566.762

PNW = control simulation
PNWCON = constant nominal tax payment
PNWCON_ER = constant nominal tax payment difference from control
PNWINC = constant real tax payment
PNWINC_ER = constant real tax payment difference from control

In the constant nominal tax case, the budget growth would be slower—at first by a small margin, but by 1990, it would be about 12 percent less than the control. In the following decade, the difference would continue to grow, but at a much slower pace. The budget growth in the constant real tax case would be much slower than the control in early years. In 1985, the differential would be approaching 10 percent. While in the previous case, the differential would grow throughout the simulation period, with this simulation it would peak in the early 1990s at about 15 percent and then gradually decline.

The slower rate of growth of the state operating budget with the deferred tax program would have a marked impact on the overall growth of the economy as indicated by the employment levels shown in Table 4. By 1990, employment levels would be 3.5 percent and 5 percent lower, respectively, when the two tax deferral programs are assumed. In later years, these differences would become smaller but would not be eliminated.

Table 4

Simulation Results — Total Employment
(thousands)

	PNW	PNWCON	PNWCON_ER	PNWINC	PNWINC_ER
1970	177.856	177.856	0.	177.856	0.
1980	189.72	189.72	0.	189.688	-0.032
1985	214.715	213.058	-1.657	210.419	-4.295
1990	273.654	264.327	-9.327	258.469	-15.186
1995	325.839	316.781	-9.058	317.933	-7.906
2000	365.37	356.456	-8.912	356.923	-8.447

PNW = control simulation
PNWCON = constant nominal tax payment
PNWCON_ER = constant nominal tax payment difference from control
PNWINC = constant real tax payment
PNWINC_ER = constant real tax payment difference from control

Because increases in employment opportunities in Alaska result in population increase through migration into the state, the deferred tax program would cause population to remain somewhat lower than in the control case. Since population affects the demand for state government services, the reduction in population would tend to reduce pressure on the balance in the general fund.

The pattern of real personal income growth in the three cases is indicative of

the fact that faster economic growth has more of a stimulative effect on Alaskan wage rates than on the cost of living. Consequently, the slowdown in employment growth marginally reduces the level of real personal income per capita in the 1980s, as shown in Table 5. In the 1990s, the differences among the cases become insignificant.

Table 5

Simulation Results — Real Per Capita Personal Income
(Real $)

	PNW	PNWCON	PNWCON_ER	PNWINC	PNWINC_ER
1978	3574.18	3574.18	0.	3574.18	0.
1980	3899.84	3899.84	0.	3899.49	-0.348
1985	4383.09	4365.93	-17.16	4339.61	-43.477
1990	5248.64	5178.45	-70.195	5141.8	-106.84
1995	5893.71	5865.15	-28.559	5908.48	14.773
2000	6454.33	6444.28	-10.047	6473.27	18.945

PNW = control simulation
PNWCON = constant nominal tax payment
PNWCON_ER = constant nominal tax payment difference from control
PNWINC = constant real tax payment
PNWINC_ER = constant real tax payment difference from control

VI. CONCLUSION

Assuming that the state budget will grow in response to an increase in the availability of revenues, a deferred tax program would have the general effect of moderating the growth of the economy. This implies that the state could pay for government services for a longer period of time from the accumulated general fund balance. For the average Alaskan, this means a longer period of time before taxes would have to be raised or service levels cut in exchange for somewhat slower growth in the level of services and of the economy in general. Since there is no obvious reason why the demand for state services ought to be functionally related to the rate of production of an oil reservoir, a longer and less cyclical level of state expenditures seems a reasonable goal.

If a tax deferral program were instituted to help achieve such a goal,[3] the form

[3]There are obviously a variety of other options. These are examined in O. Scott Goldsmith, "Alaska Revenue Forecasts and Expenditure Options," *Alaska Review of Social and Economic Conditions*, forthcoming.

of the program would determine the details of its impact on the economy. Of the two alternatives examined in this paper, the program which results in a constant nominal payment to the general fund has intuitive appeal because it implies a gradual reduction in the percentage contribution which the production tax makes to the general fund. However, to provide a constant payment within the constraint established for the life of the program requires that the initial payments be relatively large. This would result in growth of the budget in early years, which would be almost as large as in the control case.

The alternative of a constant real payment would eliminate the problem of the large, early-year fund increments since, under this alternative, payments in early years would be quite small. However, this would introduce a problem when the program was to terminate, because in that year a very significant fall in revenues would result.

Neither alternative would eliminate the basic problem of the cyclical nature of the petroleum revenues, although the latter would provide somewhat more "breathing space" for the state to adjust to a post-petroleum economy. There are undoubtedly other formulas for tax deferral programs that increase this "breathing space." Perhaps they should be examined.

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